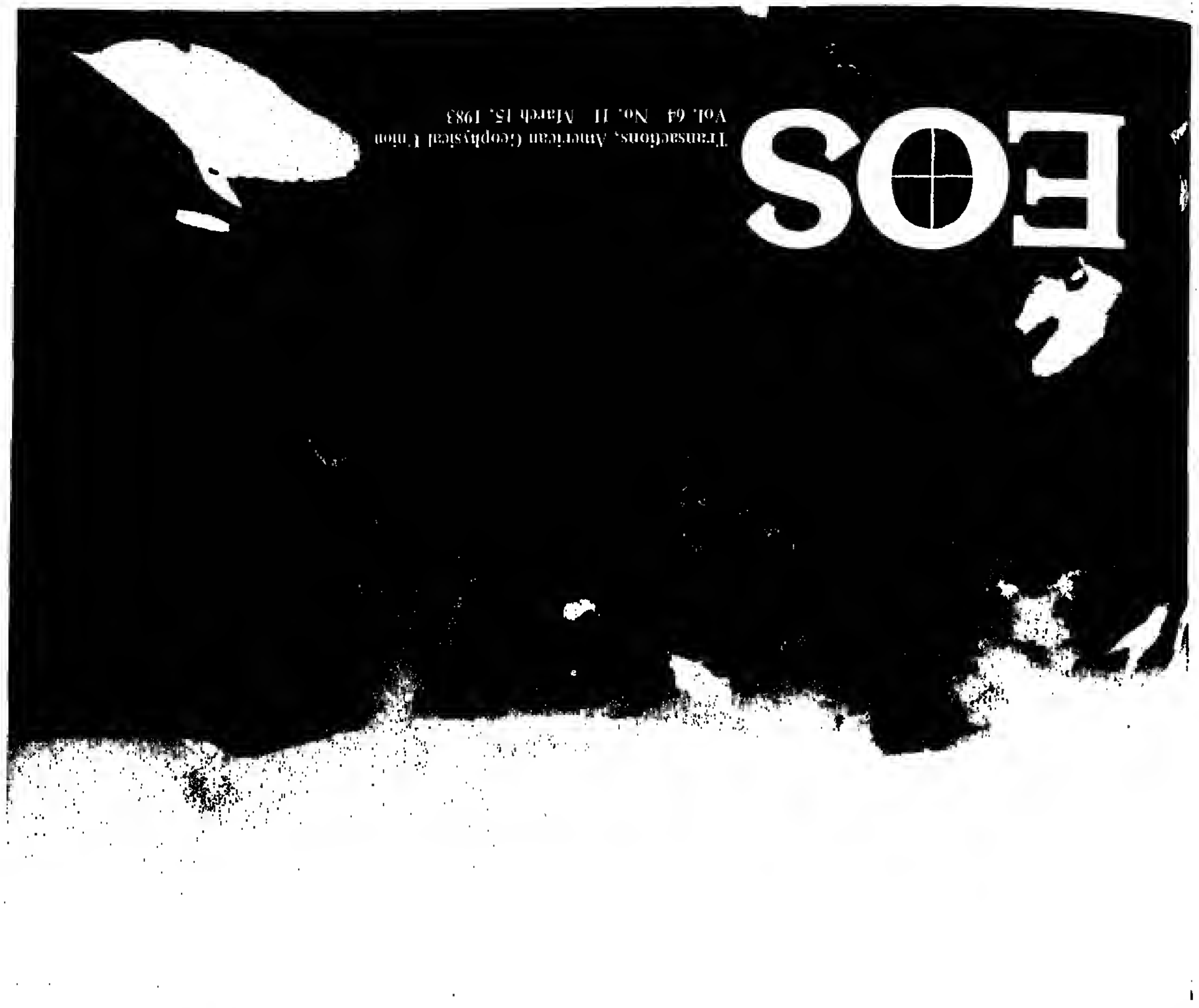

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News

Weather, Land Satellite Sale

President Ronald Reagan announced on March 8 plans to sell to private industry the nation's land and meteorological remote-sensing satellites, including the responsibility for any future ocean-observing systems. According to the plan, the private firm successful in its bid to buy the five satellites would sell back to the government the data received by the satellites. The Reagan administration says the sale will save money and will put activities appropriate for commercial ventures into the commercial sector. Response to the announcement from scientists and congressmen has been anything but dulcet; one senator, in fact, charges that the Commerce Department and the corporation most likely to purchase the satellites are engaged in a 'sweetheart deal.'

Immediate concerns expressed by scientists and congressmen over the sale of the satellites include the potential for interruption of service resulting from corporate financial difficulties or labor disputes; the possible disruption of information flow to international users of U.S. satellite data; the possibility of data being subject to copyright; and the question of a commercial satellite company having a monopoly on the satellite data essential to the U.S. government. Critics also question whether the government will save any money by selling the LANDSAT land remote-sensing satellite, the two polar orbiting satellites, and the two geostationary operational environmental satellites (GOES).

The National Weather Service (NWS), within the Commerce Department's National Oceanic and Atmospheric Administration (NOAA), would not be dismantled or sold, according to NOAA Administrator John V. Byrne.

The plan to sell the satellites, according to NOAA officials, was prompted by the Office of Management and Budget (OMB); OMB wanted to eliminate the costly LANDSAT program, which supplies information used by, among others, seismologists, geologists, farmers, and urban planners. However, because the market for the LANDSAT data is small, commercial ventures were reluctant to buy the satellite but were more interested in purchasing the weather satellites, thereby buying into the huge market for weather information. According to one current estimate, the public spends $100 million a year accessing prerecorded telephone weather information, and the media spends $1.7 billion to disseminate weather information. NOAA Administrator Byrne noted that bids would be accepted only from U.S. firms and would be accepted for either the weather satellites, the land satellite, or all of the remote-sensing satellites.

The Communications Satellite Corporation, better known as Comsat, is considered the frontrunner among the firms that would be willing to buy the remote sensing satellites. In fact, Comsat made a proposal to the government in the spring of 1981 to purchase both the land and meteorological satellites. That proposal reportedly states that Comsat would be willing to buy the satellites if the government would guarantee that it would pay roughly $300 million a year for 15 years. In a statement issued in response to Reagan's announcement, Comsat said that 'such a transfer is possible without a disruption in the service provided to national and international users and will ensure the continued development in the U.S. of this very important [satellite] technology.' A Comsat spokesman said it would be premature to comment on any possible savings that might accrue to the government as a result of the sale.

Much of the criticism of the plan stems from the apparent lack of a cost-benefit analysis to determine if the government would indeed save money by selling the satellites. At a March 14 Senate hearing on the NWS budget, Sen. Larry Pressler (R-S.D.) revealed that the Commerce Department was sent a report in November from the Department of Defense and the National Aeronautics and Space Administration (NASA) claiming that the government would spend more money buying back weather and land data from private companies than would it would spend if the government kept the satellites. In spite of this report's analysis, Pressler says, the Reagan administration has gone ahead with plans to sell the satellites. The South Dakota senator accused the Commerce Department and Comsat of being involved in a 'sweetheart deal.'

Dated November 10, 1982, the report referred to by Pressler was sent to Assistant Deputy Secretary of Commerce Michael Bayer from Major General Earl G. Peck of the Defense Department and Kathleen Charles of NASA. According to Kevin Schieffer, legislative assistant to Pressler, the report is a 'broad-base analysis' based on reports requested from more than a dozen companies on the pros and cons of the commercialization of land and weather satellites. However, the existence of the report, or any other study on the cost effectiveness of selling the satellites to the private sector, was not known to any of the more than a dozen witnesses testifying in mid March in House and Senate hearings on the proposed fiscal 1984 budget for NWS. Though labelled 'official use only,' the Peck-Charles report contains no proprietary information, Schieffer said. Pressler has requested that the Senate Committee on Commerce, Science, and Transportation ask Bayer to make the report available to scientists and others for evaluation of the costs and benefits of commercializing the remote-sensing satellites.

Pressler, whose home state is also home to the Interior Department's EROS (Earth Resources Observation Systems) Data Center, introduced into the Senate on February 15 a bill (S. 480) to block the Secretary of Commerce from transferring the ownership or management of any civil land or meteorological remote sensing space satellite system and associated ground equipment without congressional approval. Rep. Roy P. Dyson (D-Md.) introduced a companion bill (H.R. 1958) in the House on March 8, the day of Reagan's announcement. Both bills have been sent to committee. Hearings on the proposal have not been scheduled, but are likely to be held in late spring following budget deliberations.—*BTR*

UCAR Group Urges STORM Program

A blue-ribbon panel of scientists has proposed a decade-long, $1 billion program to improve forecasting operations and research of regional and local hazardous weather. The panel, appointed by the University Corporation for Atmospheric Research (UCAR), believes that the program could reduce the $20-billion annual cost of damage from severe weather by $1 billion per year.

The primary aim of the program is to 'enable weather services, public and private, to observe and predict stormscale weather phenomena—such as squall lines, thunderstorms, flash floods, local heavy snows, or tornadoes—with the accuracy and reliability to protect the public, serve the national economy, and meet defense requirements,' as explained in the report, *The National STORM (Stormscale Operational and Research Meteorology) Program: A Call to Action*. Stormscale phenomena also include nonviolent weather: freezing rain, dense ground fog, low-lying clouds that disrupt ground or air traffic, persistent temperature inversions, and strong nocturnal cooling that may produce killing frost.

'Stormscale phenomena are closely related to large-scale weather,' according to George S. Benton, professor of meteorology at the Johns Hopkins University and chairman of the UCAR committee, who testified before the House Subcommittee on Natural Resources, Agricultural Resources, and Environment on March 9. 'It is the distribution of large-scale cyclones and anticyclones—low and high pressure areas—that determines whether a broad region has predominantly stormy or fair weather. But it is the occurrence,' he continued, 'of stormscale phenomena which determines the *particular* [sic] locality within the stormy region that experiences the devastating flash flood or the destructive windstorm. Stormscale phenomena are embedded within the large-scale weather patterns, and it is often the specific location and time of occurrence of the stormscale events that are of the greatest concern to our citizens.'

The operations portion of the National STORM Program aims to deploy the technology essential to gathering, analyzing, predicting, and disseminating small-scale weather information; the research portion, on the other hand, would ensure that the new-generation, high-technology operational system would be used to its maximum benefit. The research portion of STORM also aims to train forecasters to use the new predictive techniques.

'Accurate stormscale weather forecasting will become a reality provided that the technology available to weather services is improved in four fundamental ways' under the operational part of the STORM program, the UCAR committee states in its report. First, existing remote sensing systems must be better utilized to improve the observation of stormscale weather systems. In particular, a modern radar network is needed. Second, better communication and processing systems must be made available to the forecaster, the committee contends, to permit the rapid and accurate display and analysis of local weather information from several sources. Radar or satellite pictures, for example, would show the development and movement of stormscale phenomena. Third, forecasters need better conceptual and numerical models to provide a stronger foundation not only for short-term forecasts, but also for application to forecasts of greater than 12 hours. Last, the committee says that equipment and systems must be installed to help forecasters prepare and rapidly distribute stormscale weather predictions that would be meaningful to the public.

According to the recently published report, the six-plank research program aims to (1) improve understanding of local and regional weather phenomena and to apply this knowledge to a variety of closely related fields; (2) develop and evaluate local and regional weather prediction models; (3) develop stormscale monitoring and forecasting capabilities applicable to data-sparse areas; (4) develop and test new observing systems; (5) test and evaluate systems of data assimilation, archival, and display; and (6) develop techniques of educating and training meteorologists in stormscale weather forecasting.

The three latter objectives are vital to the program and closely link the research and operations portions, Benton emphasized at a recent press conference to unveil STORM. No matter how good the predictions, they are of no value unless they can be transmitted rapidly by trained meteorologists to those people who need and use them, he noted.

The UCAR committee believes that three key ingredients have primed meteorology for a successful stormscale program: 'vastly improved understanding of and ability to predict the large-scale motions of the atmosphere'; the technology 'to observe, analyze, and disseminate stormscale weather information with a level of sophistication substantially greater than would have been possible only ten years ago'; and the 'availability of improved computers.'

At least seven major federal departments and agencies would be closely involved with the program: the departments of Commerce (in particular, the National Oceanic and Atmospheric Administration), Defense, Interior, and Transportation, the Environmental Protection Agency, the National Aeronautics and Space Administration, and the National Science Foundation (NSF). The UCAR committee encourages these agencies and departments to establish a program coordinating office as the next step in the STORM program's development. The committee also recommends that a scientific organizing committee be established within the National Academy of Sciences within the next few months and that a program advisory committee be assembled within 1983 for more detailing program planning. UCAR, a consortium of 50 universities that manages, under contract with NSF, the National Center for Atmospheric Research (NCAR), was a catalyst in developing the National STORM Program.

During 1983–1988, the first of three pro-

Editorial

On Beginning A Career

At the 1982 AGU Fall Meeting, about 50 young men and women attended a panel discussion entitled 'Doubts and Discouragements: Beginning a Career' sponsored by AGU's Education and Human Resources Committee. The panelists (Joyce Blueford, U.S. Geological Survey; Constance Sancetta, Lamont-Doherty Geological Observatory; and Percy Donaghay, University of Rhode Island) focused the wide ranging discussion on the special problems of graduate study and early professional life.

Blueford urged students to assess all of the possible careers. Too often students are exposed only to the academic teaching and research role. She suggested that each person periodically outline his or her own priorities and lifestyle to see what type of job fits, pointing out that one's desires and ideas change as one develops. To find out about job advantages and drawbacks, she suggested that one should contact graduates of one's school to see what they have done. Once the job type is determined, the young person must develop the right image, work hard, and make contacts to get ahead.

Sancetta discussed some of the problems encountered by graduate students. She felt that some drop out because they are uncertain of the direction in which they want to go. Others doubt their own ability to do creative, independent science. She stressed that these doubts are common to everyone, and that goals and confidence solidify as one advances. Another common feeling is that of being ignored and getting little support from advisors—the 'I don't get no respect' syndrome. The student feels isolated and thinks that no one really cares how he or she is doing. It is important to talk about these feelings and ask for help, she said. 'The faculty may be more supportive than you think, but they don't automatically know how you feel; you must go and tell them.'

Donaghay outlined the problems of the young professional trying to become established in a crowded field. He suggested that if one goes for 'hard money' (income provided by guaranteed salary) in academics, it means taking a heavy teaching load, which eliminates most of the research time, only to be told at promotion time that 'teaching counts for nothing; promotion is based upon publication.' Percy advised future assistant professors to check the history of promotion at each school, since standards differ. A 'soft money' (income contingent on grants) research job is often an umbrella project, in which several young scientists cooperate under the guidance of a senior scientist. This is very appealing; someone else worries about the funding while you are doing exciting work on the cutting edge, but the young scientist runs the risk of becoming an 'et al.'

'You must identify yourself as a unique scientist doing unique work,' said Donaghay. This can be done by giving talks at meetings and seminars at other institutions and by publishing papers on which you are sole author. However, as you begin to define yourself you will come in conflict with established people whose ideas you question and with whom you start to compete for funding. 'You are bound to step on a few toes sooner or later if you do exciting work, and you will have to realize that that's the way science grows and not be crushed by the fights you lose.'

Remarks by members of the audience brought out several points. An older woman suggested that young scientists adopt a mentor, an older and more experienced person willing to give advice, introduce one to senior colleagues, and explain how the system works. Several people noted that nice guys can finish first; that it is possible to be successful and self-confident while retaining a concern for others. Most students in the audience seemed to see their advisors as insensitive egotists making rigid demands; many expressed a desire that faculty give those who will not go into academics more information on alternative careers. Dr. Barbara Emery of the National Center for Atmospheric Research said that she had found teamwork boring when she performed only her part of the routine; once she took the initiative to shoulder more responsibility she enjoyed it much more. Dr. Louise Levien of Exxon Production Research Co. urged people not to give up if the first job is disappointing. 'Give science another chance in another place before you decide it's not for you.'

A problem which was discussed at some length is one of concern to young women: the apparent impossibility of sustaining a full-time, demanding job and also having a family. Aside from the personal joy of having a family, it was felt that parenting is an important contribution; but the system at present does not allow for part-time workers, who may produce less per year but are still doing valuable research. A different standard of promotion or award might be applied to such people, although it is hard to know what the standard might be; it would represent a basic change in the system. Those women who have been most successful have either been young when they had children and then worked very hard to catch up, or had children after they had become established. The panel cautioned young women not to set unreasonable goals for themselves, but to find a workable way to satisfy both parts of their lives.

The Committee plans to hold another panel at the 1983 AGU Spring Meeting, with speakers from academia, government agencies, industry, and consulting firms to discuss the relative advantages and drawbacks of various career directions.

Constance Sancetta, *Member*
Charles Hollister, *Chairman*
AGU Education and Human Resources Committee

posed program phases, the first multi-scale field experiment would be planned, a small field program with limited objectives would be conducted, and data sets would be analyzed. During the second phase (1987–1991), the later multi-scale field experiments would be planned and conducted, and analysis of the data from these experiments would begin. The last phase of the pcogram (to extend as late as 1995) would see the analysis of the data from all of the experiments completed. Throughout the entire period, other research—including modeling studies, technology development, and the transfer of information and techniques to the operational community—would be conducted.

In addition to chairman Benton, the National STORM Program committee also includes Ernest M. Agee (Purdue University); Richard A. Anthes (NCAR); Lance F. Bosart (State University of New York at Albany); Michael Fritsch (Pennsylvania State University); Peter V. Hobbs (University of Washington); John Hovermale (National Meteocological Center); Robert McClatchey (Air Force Geophysics Laboratory); Isidoro Orlanski (Geophysical Fluid Dynamics Laboratory); Frederick Sanders (Massachusetts Institute of Technology); Robert J. Serafin (NCAR); Patrick Squires (NCAR); and Verner E. Suomi (University of Wisconsin–Madison).—*BTR*

Sunspots Affect Insolation

The notion uf a rigorously constant amount nf solar radiation reaching the earth was upset recently by a team of scientists at the National Center for Atmospheric Research (NCAR). John Eddy, Ronald Gilliland, and Douglas Hoyt of NCAR's High Altitude Observatory report that sunspots, which speckle the sun's surface in a fluctuating 11-year cycle, diminish the amount of sunlight reaching the earth. Their conclusion, which may radically affect global climate modeling, is based on data gathered from the Solar Maximum Mission (SMM) satellite and their nwn solar blocking model.

Data rollected by the SMM satellite reveal that only a small fraction of the energy blocked by sunspots is balanced by immediate, enhanced emissions from bright areas on the sun. Moreover, solar energy can remain trapped in the sunspots, which have an average diameter of 9000 km, for years. Blocked radiative energy can be stored in the lower convective zone of the sun and have a 'relaxation-time scale' of 100,000 years, during which time it may slowly seep out. Fluctuating solar output affects the accuracy of global climate models that forecast long-term effects on the world's weather; Weather and climate are determined by the circulation patterns of the oceans and air, which are driven by solar energy coupled with the rotational inertia of the spinning planet.

The NCAR scientists compared data obtained from the Active Cavity Radiometer Irradiance Monitor (ACRIM) aboard the SMM satellite with terrestrial surface temperature data and, using their solar blocking model, successfully duplicated the patterns of energy fluctuations. They can now predict the short-term excursions in solar radiation a few days in advance, the scientists say, based on measurements of sunspot areas and their locations along with the known rotational properties of the sun. In addition, they can reconstruct the history of past fluctuations in solar radiation from the archived sunspot data of the past 108 years.

Launched February 14, 1980, the SMM satellite has detected variances of 0.1% in solar energy output. Such fluctuations correspond to a change of 10 °C in the average temperature of the sun, which is 5700 °C. If the variance is persistent, the scientists say, the earth's surface will respond directly and predictably: global cooling will follow a decrease in solar radiation and global warming will follow an increase.

Theoretically, fluctuations in the release of solar energy can affect climate profoundly (*Eos*, August 26, 1980, p. 596). Mean global temperatures would drop more than 1 °C in response to a 1% decrease in output of solar radiation. A drop in output of energy of only 6% would cover the entire earth with ice.—*MEG*

Long Valley Earthquakes Wane

The intense swarm of earthquakes that began January 6, 1983, in the Long Valley region of eastern California continues to abate. The rate of earthquakes of magnitude 1 or greater (Richter scale) fell to 24 per day by February 8, compared to 100 per day in late January and 1000 tremblers recorded on January 7. Prior to the current swarm, the average daily number of magnitude 1 or greater quakes was 8–10. The area has experienced more than eight seismic swarms since the four magnitude 5.6–6.1 earthquakes of May 25–27, 1980, that occurred in the southern part of the Long Valley caldera. Early ground deformation measurements indicate limited movement of magma deep within the earth.

However, despite the current abatement, recent brief flurries of activity were recorded when two magnitude 4 and one magnitude 3.5 earthquakes occurred on February 3 and 4, respectively. In addition, a magnitude 4.1 earthquake was recorded on February 24.

The seismic activity that began in January has resulted in ground extensions of 3 cm in 6 km and uplifts of 8 cm as indicated by laser-distance measurements and precision surveying. According to U.S. Geological Survey (USGS) seismologist David P. Hill, the changes are more pronounced near the epicentral region which is 3 to 8 km east of the town of Mammoth Lakes. The town is located on the southwest edge of the 17 km by 32 km elliptical caldera. Spasmodic tremors also have been recorded at this site.

Volcanologists consider spasmodic tremors as indicative of rock fracturing caused by the movement of magma or magmatic gases (*Science*, June 18, 1982, p. 1302). Reanalysis of the May 1980 earthquakes indicates that they were the result of a rapidly expanding crack that immediately filled with fluid. A USGS preliminary model to account for the latest deformation suggests movement of up to 20 cm on the seismically defined fault zone, accompanied by up to 76 cm of opening within that zone. The right-lateral slip movement is consistent with the seismically determined mechanism for the earthquakes according to Hill.

Previous seismic studies revealed the existence of a magma chamber near the town of Mammoth Lakes. Approximate measurements place it at a depth of between 8 km and 15 km and a distance across of 10 km. The 1980 tremors and the appearance of steam vents in January 1982 in the caldera region indicated to researchers that magma from deep in the earth was moving upward (*Science*, June 18, 1982, p. 1302).

Despite the recent decline in seismic activity, the Long Valley-Mammoth Lakes area remains covered by a notice of potential volcanic hazards issued by the USGS in May 1982. The region also is under an earthquake hazards watch, which has been in effect since May 1980.

Wet February for Nation's Streams

Februaty marked a very wet month for the nation's streams with 97% of the key index gaging stations across the country reporting average to above-average streamflow, according to the U.S. Geological Survey.

USGS hydrologists said that the only stations that reported below-normal conditions for February were one gaging station each in New York, New Jersey, Ohio, and Alaska and all four of the key index stations in the Hawaiian Islands.

The near drought conditions on the Hawaiian Islands were a strong contrast to the generally wet conditions across the continental United States. All four of the key index gaging stations on the Islands reported streamflows well below average for February. On the large Island of Hawaii, the key index gage on Waiakea Stream near Mountain View reported several days of zero flow during the month. Kilauea Volcano, located on the Island of Hawaii, has erupted several times during the past two months, and the lack of moisture combined with the intense heat from the lava flow increased the threat of vegetation fires on the island.

As an indication of the nation's generally plentiful water picture, combined flow of the nation's 'Big Five' rivers—Mississippi, St. Lawrence, Columbia, Ohio, and Missouri—averaged 889 billion gallons a day (bgd), 11% above the long-term average for February. The Big Five, which together drain more than half of the conterminous United States, provide hydrologists with a convenient check on overall national water conditions.

February marks the ninth straight month that the combined flow of the Big Five has been above average. Near the end of February, total daily flow of the Big Five was running 24% above the long-term combined monthly average, indicating that wet conditions could extend at least into early March.

Increased streamflows in February helped to halt a developing drought threat along much of the East Coast and inland to southern Alabama. All but two of the 31 key index gaging stations in New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, Kentucky and Tennessee reported average to above-average streamflow during February. In contrast, during January each of these states had reported well-below average streamflow at one or more index stations.

Working in cooperation with federal, state and local officials, USGS hydrologists routinely collect data on streamflow and ground-water conditions at more than 45,000 sites across the country. Highlights of February water conditions:

Big Five: Individual February flows—Mississippi River near Vicksburg, Miss., 494 bgd, 13% above average, but down 27% from January's flood volume; St. Lawrence River near Massena, N.Y., 158 bgd, 5% above average and 6% above the January average flow; Columbia River at The Dalles, Ore., 89 bgd, 33% above average and 8% above last month's flow; Ohio River at Louisville, Ky., 88 bgd, 22% below average, but up 44% from the January flow; and the Missouri River at Hermann, Mo., 60 bgd, 87% above average and 17% above last month.

Ground-water conditions: Ground-water conditions varied across the country. The water level in key index wells in Kentucky, Nebraska, North Dakota and Nevada set new record highs for February. All four of the key index wells in North Carolina reported water levels that were one to four feet above the long-term average. Ground-water conditions in Delaware and Maryland remained well below average, with one key index well near Fairland, Maryland, reporting the 29th consecutive month of below-average water levels. The water level in a key index well near El Paso, Texas, fell to 78 m below the land surface, the lowest level reported at this well in 18 years of record.

Detecting Electron Precipitation

Preliminary results were recently reported from the Navy's Stimulated Emission of Energetic Particles (SEEP) satellite regarding detection of stimulated magnetospheric electron precipitation from ground based Navy VLF transmitters (*Eos*, January 18, 1983). The results, first released at the AGU Fall Meeting, were obtained on passes during mid-August 1982, using coded transmitter pulses with a duty cycle of 3 s 'on,' 2 s 'off.'

We note here that a similar experiment was conducted by the National Aeronautics and Space Administration (NASA) using low-cost, recoverable rocket payloads from Wallops Island, Virginia, during late June and early July 1982. These flights also used the Navy VLF transmitter (NSS) at Annapolis, Maryland, with the same coding as that used for the later SEEP experiment. Participants in the NASA experiment included scientists from Goddard Space Flight Center, Denver University, and Cornell University. The results of this experiment, also reported at the AGU Fall Meeting, show evidence for pulsed electron precipitation patterns with the same period as the transmitted VLF pulses. These results were accomplished by sensing the bremsstrahlung X rays produced when the electcons reenter the atmosphere. A zenith-viewing, wide angle X ray detector was stabilized with a slow descent oboard a parachute-hung payload; this peroitted a statistical build-up of the X ray signals over thirty 5-s cycles, a benefit not afforded by a fast moving satellite. Cross correlation analyses of the X ray data with the transmitted signal clearly demonstrated the existence of this effect at a detectable level under nighttime conditions. The SEEP results, which measured the precipitating electrons in situ, are consistent with these earlier NASA findings.

The NASA result was used to establish the role of both anthcopogenic and natural VLF sources as a magnetospheric stimulant. In particular, lightning appears to be a reasonable candidate for producing a continuous stream of magnetospheric electron drizzle, since approximately 2000 thunderstorms occur over the globe at any instant. Comparisons of the VLF energy from the VLF transmitter to that from lightning were made with onboard VLF receivers and show the lightning source to be larger on average by a factor of 10. More details on the NASA results can be found in an upcoming issue of *Science* under the title 'Controlled Stimulation of Magnetospheric Electrons by Radio Waves: Experimental Model for Lightning Effects' by R. A. Goldberg et al.

This news item was submitted by R. E. Hartle of the NASA/Goddard Space Flight Center, Laboratory for Planetary Atmospheres, Greenbelt, MD 20771.

Forum

Research Funds

Joseph Walder's rambling diatribe against accepting research funds from the Department of Defense (*Eos*, December 28, 1982, p. 1346) deserves some rebuttal in particular, I would like to respond to his question, 'Does acceptance of financial support from military sources make individuals and institutions dependent clients of the Pentagon?' The answer is: of course not, unless they want to be.

As an Air Force scientist and research contract manager, I can state categorically that we put no pressure upon our contractors to become our 'clients.' Indeed, we caution them not to become too dependent upon Air Force funds for continued funding of research projects, due to year-to-year changes in programs of interest to the Air Force and availability of funds. The only 'control' that we exert over contractors is their voluntary agreement to perform the work that they have unilaterally proposed to do by submitting an unsolicited proposal to us. These proposals are reviewed in-house, and funding is determined purely on relevance, availability of funds, and our estimate of the quality of the proposed research (investigators, facilities, etc.).

Thus, funding of a research project by the Air Force, at least in nonsensitive areas, is more volatile and has only slightly more stringent requirements (e.g., we usually require one scientific report or journal paper per year) than does funding by the National Science Foundation. This hardly makes our contractors our 'clients,' which I am sure can be attested to by the many innovative research scientists who have been funded by us over the years.

Richard C. Allred
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Another AGU Index

I note that Juan G. Roederer has proposed an index of AGU affiliation named JGR (*Eos*, October 19, 1982, p. 817). According to this index, Alaska is the most AGU-involved state in the Union. I praise his customary modesty in disclaiming any connection between his initials and the name of the index. I think it only fitting that the index be applied on a worldwide basis since AGU is many ways transcends national boundaries, as indeed its subject matter does.

I propose that the worldwide index, applied to each country as the JGR index is applied to the states, should be named after either a well-known magnetic index or the Atmospheric Explorer spacecraft, i.e. it should be known as the AE index. I, of course, emulate Dr. Roederer in disclaiming any connection with my initials.

A hot second this goal of the world with the AE index shows that Israel has an index of 10 compared with 2×10^{-7} for Egypt and even smaller values for other countries in the region. India has approximately the same number of AGU members as Israel with a population more than two orders of magnitude greater. Thus, it appears that Israel is the most AGU-oriented country in Asia.

Aharon Evistar
Tel Aviv University
Tel Aviv, Israel

Education Bill Passes

On March 2 the U.S. House of Representatives passed a bill authorizing $425 million for science and mathematics education in fiscal 1984; the authorization is $360 million more than President Ronald Reagan requested in his budget proposal (*Eos*, February 15, 1983, p. 85).

H.R. 1310 allocates $295 million to the Department of Education not only to improve precollege instruction in science and math, but to beef up foreign language training to aid in improving international communication among scientists. The bill also allots $100 million to the National Science Foundation for a variety of programs, the lion's share of which aims to upgrade research equipment at colleges and universities. It is hoped that industry will match the $100 million targeted for this program.

Although the Senate has yet to draw up a companion bill, hearings were held by the Education, Arts, and Humanities subcommittee of the Senate Labor and Human Resources committee on March 8 and 9 on the Education Security Act and related science and mathematics legislation. Follow-up hearings are scheduled for April 7.—*BTR*

Books

Introduction to Tides: The Tides of the Waters of New England and New York

A. C. Redfield, Marine Science International, Woods Hole, Mass., 108 pp., 1980.

Reviewed by Malcolm J. Bowman

This interesting little book is not really about what its main title suggests, an introductory text on tides for oceanography students. Its subtitle gives more of a clue to its contents and intended readership. The author immediately points out in the preface that 'this book is written for the many intelligent people who work or play along the coast between Sandy Hook and the Bay of Fundy.'

In addition to discussing elementary tidal theory, the book describes in some detail the author's systematic analysis of coastal tides and currents in the New England and New York region. His analysis fits the solution of the telegrapher's equation to Tide Table predictions of tidal elevations and times of high water and slack current. In this way, Redfield separates the observed M_2 tides in various straits, embayments, hydraulic channels, and estuaries into damped, progressive waves travelling in opposite directions. These waves arise through reflection of the primary wave at the head of an embayment or estuary, or through two primary waves entering a tidal strait or hydraulic channel from both ends.

Using a nomographic method, the technique produces curves nf mean tidal range and times of high tide and slack water along the waterway for optimum estimates of the damping and reflection coefficients. These predictions, well known from Redfield's pioneering use of the method in his series of papers during the 1950's, are quite good for the tidal height and interval but not for slack water. This is to be expected, since the equations were originally developed for use in a rectangular uniform channel, and take no account of the effects of weather, overtide generation, the earth's rotation, bathymetry, and varying cross sections of the waterways studied.

Unfortunately, most of the intended readers will probably not understand the summary of the theory as given in chapter 3, nor, therefore, its application; they will have to read the original papers for that. Even then only those familiar with elementary trigonometry and calculus will make much sense of it. (Coastal engineers have made much use of the method and a particularly good discussion is given in A. T. Ippen and D. R. F. Harleman, Tidal dynamics in estuaries, in *Estuary and Coastline Hydrodynamics*, edited by A. T. Ippen, McGraw-Hill, New York, 1966.)

Another criticism one could make of the text is that no mention is made of the whole realm of numerical tidal modeling. Numerical simulations are now sufficiently easy to apply and accurate to be of major importance in the production of tidal atlases of semi-enclosed seas and navigable waterways. In spite of this, and allowing for the limitations inherent in the fitting of linear, one-dimensional, damped wave theory to coastal tides, the book is immensely readable and will find its way in the bookshelves of mariners, amateur scientists, and oceanographers all along the northeastern seaboard. Professional coastal oceanographers will also find it a quick source of useful facts and figures.

One thing Alfred Redfield does not disclose is the secret of his longevity. How a man had the energy and lucidity to produce such an interesting book as he approached his ninetieth birthday is a source of wonder to me. Perhaps the characteristics cited by the late Bostwick H. Ketchum in his foreword ('his interest in natural phenomena and his curiosity about them have been undiminished by passing years') have had a lot to do with it.

Malcolm J. Bowman is with the Marine Sciences Research Center, State University of New York at Stony Brook.

Igneous Rocks of the British Isles

D. S. Sutherland (Ed.), Wiley-Interscience, New York, xv + 645 pp., 1982.

Reviewed by K. L. Currie

Much of the foundation of petrology was laid on the igneous rocks of the British Isles—one need only recall the Tertiary igneous rocks of northern Scotland. However, the relations between various occurrences of these igneous rocks (and in some cases even their locations) have remained obscure for many nf us familiar with the British Isles only through the voluminous literature. This weighty and loosely written tome will serve as a most useful guide and reference for all those interested in British igneous rocks. The volume specifically aims to continue that grand classic of observational geology, *Ancient Volcanoes of Great Britain* by Archibald Geikie. It does not achieve quite that level but will surely remain an indispensable general reference for many years if only because of its extensive bibliography.

The volume includes contributions by 37 coauthors divided into seven parts and three appendices. The rocks have been divided according to age and type, namely the Precambrian, Lower Paleozoic volcanic rocks, Caledonnian intrusive rocks, Devonian and Carboniferous volcanism, Hercynian intrusive rocks, Late Paleozoic and Mesozoic igneous activity, and the British Tertiary province; petrographic, chemical, and isotopic details are relegated to three appendices. Each part is further broken down into a general introduction followed by several articles on particular occurrences or aspects of the igneous rocks.

The usefulness of reference books of this kind depends on the quality of the introductory chapters and on the completeness of the indices. In both respects this volume rates high. The indices are exceptionally good, and the introductory chapters do a good job at placing the later material in context, although I was rather overwhelmed by the profusion of place names. This generally laudatory comment does not imply that anyone can readily sit down and get an overall picture of the igneous history of the British Isles from this book. In the first place there are certain difficulties of organization, perhaps inevitable. Only peripherally and in passing is it noted that the part on Devonian and Carboniferous volcanism treats rocks contemporary with, and possibly comagmatic with, Caledonian and Hercynian intrusives. The quality of the writing varies from pedestrian to extremely dense. I found it heavy going because nf the wealth of references and the attempt to get the maximum number of facts into the minimum amount of space. Still, the facts are there if the reader will dig for them. A wealth of small locality maps greatly aid the visualization. Occasionally these maps cannot be easily referred to larger scale maps, but in general the 'hierarchical' organization is good. The number of photos is limited, but their quality is excellent.

The various articles treat mainly of descriptive aspects of the rocks with sketches and localities. Some authors treat bulk chemical data by presenting various diagrams, but there is little treatment of mineral chemistry or of specialized chemical data such as rare earths, although such details can in general be traced in the very extensive bibliography. Treatment of petrological problems is sketchy and superficial. Some sections are quite repetitive, particularly the one on the Tertiary, where Mull and Arran are treated in three successive articles. The distribution of space may seem somewhat idiosyncratic also. The Tertiary rocks receive the most space, 133 pages, which is not unreasonable, but 54 pages for the celebrated Hercynian granites of Cornwall, when compared with 88 pages for Carboniferous-Permian volcanism and 88 for lower Paleozoic volcanism, seems somewhat unbalanced. The selection of data for the appendires exhibits some peculiarities. The appendix on petrography starts off with a modest encomium to the Streckeisen classification and then reverts to such terminological monstrosities as 'marscoite,' 'tregelvalite,' and 'rockallite.' According to the chemical data, trace element analyses are rare or absent for the Tertiary province and for the Caledonian intrusives.

Despite these reservations, the book dearly succeeds in its object of giving condensed descriptions of the significant localities of igneous rocks in the British Isles. The question remains whether there is a clientele for such a large, expensive, and specialized book. It cannot be read for sheer pleasure, unlike its distinguished predecessor, *Ancient Volcanoes of Great Britain*. The quantity and level of information are insufficient for specialists wishing to study a particular complex either in the field or in the literature, although it will undoubtedly be of great use as a guide and entry to the literature. The obvious place for this book is therefore on the reference shelf of libraries, where it will doubtless remain the standard work on the subject for many years. Few individuals will be interested in this book for their private library.

K. L. Currie is with the Geological Survey of Canada, Ottawa, Ontario.

EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

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Cover. Roll clouds spell trouble; they are often on the leading edge of heavy thunderstorms that can produce hail, high winds, and heavy rain. The clouds, such as those over Miles City, Mont., pictured on the cover, are but one of the many phenomena portending geographically limited but severe stormscale weather. A call for action has been issued for a National STORM (Stormscale Operational and Research Metcorology) Program to enable meteorologists to observe and predict such small-scale weather and to apply the improved predictions to protecting the public, the national economy, and meeting defense requirements. Proponents of the 10-year, $1-billion program say it could save 5% of the annual $20 billion lost to severe weather. See related news story, this issue. (Photo courtesy of Phil Roykowski, National Center for Atmospheric Research/National Science Foundation.)

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AGU Panel Meets On Career Topics

Graduate students and their career opportunities in ocean and earth sciences were the focus of the Education and Human Resources (E & HR) Committee meeting held at the 1982 AGU Fall Meeting in San Francisco. A standing committee of AGU, the E & HR committee is responsible for matters concerning education in earth, ocean, and planetary sciences from precollege through graduate programs, including career guidance, academic preparation, student recruitment, and manpower supply and demand.

At the meeting a draft of the AGU-sponsored *Careers in Oceanography* booklet by committee chairman C. Hollister was thoroughly discussed and a new draft will emerge soon for final approval. The booklet is designed to complement the *Careers in Geophysics* booklet recently published by AGU; the booklets contain information about planning a career, job opportunities, educational requirements, and a synopsis of where the prospective student might apply.

Among other topics discussed were the following items: (1) AGU-sponsored lectureships for graduate student recruiting in oceanography; with no volunteers and no money for such lectureships, the booklet and individual efforts will have to suffice as recruiting devices; (2) AGU women's sessions sponsored by this committee will drop special reference to women, but the panel at the 1983 AGU Spring Meeting (Louise Levien, chair) will compare the advantages and drawbacks of careers in academia, industry, government or consulting; (3) the E & HR Committee will be developing a membership-wide questionnaire in order to improve and perhaps increase the committee's service to AGU.

The new edition of *Geophysics—The Earth in Space*, AGU's career booklet for high school students, is now available. The material has been updated and the format changed and expanded by use of pictures. In addition to the revision of this booklet, AGU has within the last year produced *Careers in Geophysics*, which is aimed at undergraduate and graduate-level college students, and the above-mentioned draft of an additional booklet on careers in oceanography. Individual copies of both *Geophysics—The Earth in Space* and *Careers in Geophysics* are available free of charge to students. In addition, larger supplies are available to professors and guidance counselors for their students upon specific request.

At the Fall Meeting our committee also sponsored a panel discussion (chaired by C. Sancetta) on 'Doubts and Discouragements: Beginning a Career.' About 50 people attended and a report of the session may be found in the Editorial section of this issue of *Eos*.

Charles Hollister
Woods Hole Oceanographic Institution
Chairman, AGU Education and Human Resources Committee

Meetings

Announcements

Ocean Data Presented

A large portion of the unpublished marine geological and geophysical data gathered in 1982 in the Aleutian-Bering Sea and the southwestern Pacific by the U.S. Geological Survey (USGS) research vessel RV *S. P. Lee* will be made available at a one-day 'show-n-tell' at the USGS in Menlo Park, Calif., on April 5, 1983. The data was collected as part of the Circum-Pacific Project, a cooperative effort involving about 25 countries that began last May. The project includes studies of active volcanoes along the Pacific 'ring of fire' and exploration for new oil, gas, and mineral resources.

Among the data to be displayed is that gathered from petroleum prospective areas near Tonga, Vanuatu (New Hebrides), and the Solomon Islands.

Michel T. Halbouty, chairman of the Circum-Pacific Council for Energy and Mineral Resources, will open the symposium with a keynote address on the national importance of scientific investigations of the Circum-Pacific rim. His address will be followed by a series of brief papers describing the purpose and nature of the work being exhibited, and some of the more important initial results.

Although no registration is required, those interested in attending should call Florence L. Wong (telephone: 415-856-7042) at the USGS in Menlo Park, Calif. General information about directions, local travel, and lodging may be obtained from Fran Moyer (telephone: 415-856-7143).

The 'show-n-tell,' the first of several symposia and workshops to be sponsored by the circum-Pacific section of the American Association of Petroleum Geologists (AAPG), also is sponsored by the Pacific marine geology branch of the USGS.

GAP

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Aeronomy

0410 Absorption and scattering of radiation (particles or waves)
THE AERONOMIC DISSOCIATION OF WATER VAPOUR BY SOLAR H LYMAN α RADIATION
B. A. Lewis, I. M. Vardavas and J. H. Carver (Research School of Physical Sciences, The Australian National University, Canberra, ACT, 2600, Australia)

The photoabsorption cross sections of molecular oxygen and water vapour have been measured as a function of temperature at 0.1 Å intervals between 1214 and 1219 Å. Over the width of the solar Lyman α line there is no fine structure apparent in the cross sections which were measured with 0.08 Å resolution. [illegible]

Geophys. Res. Lett., Paper 3L0325

[illegible]

... simultaneously measure ozone density, temperature, and solar ultraviolet flux. Results from six months of observations show that ozone density in the mesosphere changes from day-to-day and with the seasons and that the principal cause of these changes is the variation in atmospheric temperature. The dependence between ozone density and temperature is inverse, with a decrease in temperature producing an increase in ozone density. This dependence is observable in the seasonal patterns and also in orbit-to-orbit observations during dramatic atmosphere changes such as stratospheric warmings.

Geophys. Res. Lett., Paper 3L0322

0430 Composition
OZONE DENSITY DISTRIBUTION IN THE MESOSPHERE (50-90 KM) MEASURED BY THE SME LIMB SCANNING NEAR INFRARED SPECTROMETER
R.J. Thomas (Laboratory for Atmospheric and Space Physics and Department of Astro-Geophysics, University of Colorado, Boulder, CO 80309) C.A. Barth, G.J. Rottman, D.W. Rusch, G.H. Mount, G.M. Lawrence, R.W. Sanders, G.E. Thomas and L.E. Clemens.

The ozone densities between 50 and 90 km are deduced from 1.27 μm airglow measured on the Solar Mesosphere Explorer satellite. The derived densities agree well with those made simultaneously from SME by the ultraviolet spectrometer. The data set extends from pole to pole at about 3 pm, for most sunlit latitudes. At low altitudes, in the mesosphere, there are larger variations in ozone density in the winter latitudes than in the summer. Above the meso-pause the day-to-day variation in ozone density is a factor of two at most latitudes and times.

Geophys. Res. Lett., Paper 3L0301

0430 Composition
MESOSPHERIC OZONE DEPLETION DURING THE SOLAR PROTON EVENT OF JULY 13, 1982 PART I MEASUREMENT
R.J. Thomas (Laboratory for Atmospheric and Space Physics and Department of Astro-Geophysics, University of Colorado, Boulder, CO 80309) C.A. Barth, G.J. Rottman, D.W. Rusch, G.H. Mount, G.M. Lawrence, R.W. Sanders, G.E. Thomas, and L.E. Clemens.

The near infrared spectrometer and the ultraviolet spectrometer on the Solar Mesosphere Explorer (SME) observed the ozone density as a function of latitude and altitude during the solar proton event of July 13, 1982. Airglow at 1.27 μm was observed at the earth's limb. The altitude profiles of the emission were inverted providing ozone densities. The ozone densities observed showed a clear decrease during the event. [illegible]

Geophys. Res. Lett., Paper 3L0325

[illegible]

0430 Composition (atomic or molecular)
MESOSPHERIC OZONE DEPLETION DURING THE SOLAR PROTON EVENT OF JULY 13, 1982 PART II. COMPARISON BETWEEN THEORY AND MEASUREMENTS
S. Solomon [illegible]

[illegible]

0430 Composition
MEASUREMENTS OF NO_2 IN THE EARTH'S STRATOSPHERE USING A LIMB SCANNING VISIBLE LIGHT SPECTROMETER
[illegible]

NO_2 densities measured from the limb scanning visible light spectrometer on board the Solar Mesosphere Explorer spacecraft are reported for winter 1981/82 in the altitude region 20-40 km. The observational technique utilises the photoabsorption by NO_2 of Rayleigh scattered sunlight in the 440nm spectral region. The NO_2 density varies from pole to pole and shows large variations at high northern latitudes during the winter months which are related to both the temperature and flow of air near 30 km.

Geophys. Res. Lett., Paper 3L0328

[illegible]

... The [illegible] mesosphere, stratosphere and troposphere is demonstrated using recent results obtained from the MST radar at Poker Flat, Alaska. Mesospheric results include mean flow, tidal motions and shorter term fluctuations. Stratospheric-tropospheric results include, in addition, high-frequency (> 15°) wave-like fluctuations observed in the vertical wind field.

Rad. Sci., Paper 3S0378

Physics of the Solid Earth
Volume 18, Number 5

CONTENTS

SCIENTIFIC COMMUNICATIONS

CHRONICLE

Electromagnetics

0720 Electromagnetic Theory
WAVE PROPAGATION ON A STRIP GRATING OVER AN IMPEDANCE PLANE. SOLUTION BY REDUCTION TO A MODIFIED RIEMANN-HILBERT PROBLEM
A.M. Barbosa (Centro de Análise e Processamento de Sinais, Complexo Interdisciplinar, Instituto Superior Técnico, Av. Rovisco Pais, 1096 Lisboa Codex, Portugal), A.F. dos Santos and J.Figanier
The TM electromagnetic wave propagation along a strip grating above an impedance plane is studied. The problem is formulated in terms of a modified Riemann-Hilbert problem. The modal equation of the structure is derived and solved numerically. Surface wave and leaky wave modes are identified. Phase velocity and attenuation constant of the dominant leaky wave modes are presented and their dependence on frequency and geometrical parameters is discussed. The possibility of application of this structure to the design of a leaky-wave antenna is suggested. (strip grating, electromagnetic wave propagation, leaky waves, Riemann-Hilbert problem).
Rad. Sci., Paper 3S0407

0770 Radio Oceanography
PARAMETRIC DEPENDENCE OF OCEAN WAVE-RADAR MODULATION TRANSFER FUNCTIONS
W. J. Plant (Environmental Sciences Division, Naval Research Laboratory, Washington, DC 20375), W. C. Keller and A. Cross
During the Marine Remote Sensing experiment of 1979 (MARSEN 79), we employed microwave techniques at X- and L-Band to determine the dependence of ocean-wave radar modulation transfer functions (MTFs) on various environmental and radar parameters. In this paper, we present these MTFs along with coherence functions between the AM and FM parts of the backscattered microwave signal and show that they both depend on several of these parameters. In addition to confirming many of the properties of transfer functions reported by previous authors, this work indicates that MTFs decrease with increasing angle between wave propagation and antenna-look directions but are essentially independent of small changes in air-sea temperature difference. Coherence functions are much smaller when the antennas are pointed perpendicular to long waves, however. X-Band transfer functions measured with horizontally polarized microwave radiation are found to have larger magnitudes than those obtained using vertical polarization. Under conditions encountered in this experiment, transfer functions are independent of long-wave amplitude when waves and antennas are aligned. Coherence functions, however, depend strongly on long-wave amplitude. We show that this dependence implies that in addition to being modulated by long waves, short waves amplitudes fluctuate in response to environmental factors unrelated to long waves. Spectral densities of these fluctuations are shown to be comparable to those of modulations induced by long waves.
J. Geophys. Res., Green, Paper 3C0492

0771 Remote Sensing
ANALYSIS OF CORREGISTERED LANDSAT, SEASAT AND SIR-A IMAGES OF VARIED TERRAIN TYPES
Ph. Rebillard and O. Evans (Jet Propulsion Laboratory, California Institute of Technology, MS 183-701, 4800 Oak Grove Dr., Pasadena, CA 91109)
Multisensor image data (SIR-A, Seasat SAR and Landsat MSS) over areas in northern Algeria and western Utah have been coregistered in order to assess the complementary effects of the orbital sensors for geologic mapping in two very different terrains. This first attempt at registering such a data set shows that the radar backscatter information provided by the SIR-A image increases the classification accuracy of several geologic units over the Landsat image alone, and over combined Landsat and Seasat images.
Geophys. Res. Lett., Paper 3L0303

Exploration Geophysics

0910 Computer applications
NUMERICAL ANALYSIS OF THE 45-DEGREE FINITE-DIFFERENCE EQUATION FOR MIGRATION
Henry Brysk (Teledyne Exploration Co., P.O. Box 36269, Houston, TX 77036)
Migration is now most commonly performed by means of a finite-difference solution of the wave equation in the space-time domain (although alternative approaches such as f-k, Kirchhoff, finite-difference in the space-frequency domain have strong adherents). Claerbout's derivation of the 15-degree paraxial ray equation and its iteration to the 45-degree equation are well documented. On the other hand, the transcription of the differential equation to a finite-difference scheme has accreted with practical computing experience and is only mentioned piecemeal (when at all) in the literature. The full expression is reviewed here, as used in a typical production code. A numerical stability analysis of the von Neumann type is applied to the complete finite-difference equation. It proves that the computer algorithm is stable, at least for the values of the computational parameters in normal use (the sensitivity to the values of these parameters is illustrated.) Thus, any perceived noisiness of migrated sections cannot be blamed on computational precision. The shortcomings are entirely caused by deficiencies in the analytic framework and the modeling.
GEOPHYSICS, VOL. 48, NO. 5

0510 Computer applications
DIGITAL FILTERING WITH THE SECOND MOMENT NORM
See 0930 Seismic methods
L. R. Lines (Amoco Production Company, P.O. Box 591, Tulsa, OK 74102) S. Treitel
The Backus-Gilbert inverse method relates model estimates to actual earth models by use of a resolving kernel. This inversion can in turn be related to various digital filter designs. If the second moment norm is used to define the resolving kernel, two types of filters are produced by an eigenvector decomposition of a time-weighted autocorrelation matrix. The eigenvector corresponding to the largest eigenvalue of this matrix is similar to the output energy filter, while the eigenvector for the smallest eigenvalue performs more like a deconvolution filter. Synthetic and real data examples demonstrate the characteristics of these filters and compare them to the familiar square norm filters. Our experiments suggest that second moment norm filters offer no significant advantages over their Euclidean norm relatives.
GEOPHYSICS, VOL. 48, NO. 5

0930 Seismic methods
VERTICAL SEISMIC PROFILING: SEPARATION OF UPGOING AND DOWNGOING ACOUSTIC WAVES IN A STRATIFIED MEDIUM
S. Seeman (Etudes et Productions, Schlumberger, 26 Rue de la Cavee, 92140 Clamart, France) L. Horowicz
One of the essential steps in the processing of a vertical seismic profile is the separation of upgoing and downgoing signals. With this perspective in mind, seismic data recorded in a borehole are modeled in terms of these waves and a mathematically optimal "least-squares" technique for extracting them is derived. The method imposes practically no constraints on the spacing between recording levels and allows almost perfect rejection of a coherent downgoing signal.
The exact formulation of the one-dimensional model requires that acoustic impedance information be included, but a reasonable and realistic approximation can neglect impedance. We derive frequency-wavenumber response plots for the two limiting cases of even and randomly spaced levels and compare them to the response of a "conventional" velocity filtering technique. By a careful study of available logs, recording levels can be chosen to optimize geophone coupling rather than insisting on uniform spatial sampling. Data editing, normalization, and true amplitude recovery (TAR) are required prior to application of the technique. The TAR correction can be computed from sonic log data, which emphasizes the possibility of more complete synergism between the seismic and logging worlds.
GEOPHYSICS, VOL. 48, NO. 5

0930 Seismic methods
SEISMIC CHARACTERISTICS OF A PRECAMBRIAN PLUTON AND ITS ADJACENT ROCKS
Z. Hajnal (Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada S7N 0W0) M. R. Stauffer, M. S. King, P. F. Wallis, H. F. Wang, and L. E. A. Jones
Surface, borehole, and laboratory acoustic measurements all confirm the existence of a near-surface low-velocity zone in metavolcanic, metasedimentary, and plutonic rocks of the Flin Flon region of Canada. This zone is caused by a high frequency of open fractures and extends from the surface to depths of between 5 and 40 m, although occasional open fractures extend to at least 80 m.
There is a linear decrease in sonic velocity with increasing frequency of large fractures; the details, however, vary for different sites, depending upon several geologic features including rock type and nonfracture porosity. Laboratory sonic data indicate very low microcrack densities in the volcanic and plutonic rocks.
Synthetic seismograms derived from sonic log information from the center of the granitic pluton have been compared with a nearby multifold seismic profile. This shows that the near-surface low-velocity zone attenuates most of the high-frequency seismic energy. However, the remaining low-frequency portion of the seismic spectrum can be used to map some features of the pluton.
GEOPHYSICS, VOL. 48, NO. 5

0930 Seismic methods
AUTOMATED ANALYSIS OF WEBLES REFRACTION DATA: A COMPUTER ALGORITHM
C. Patrick Ervin (Department of Geology, Northern Illinois University, DeKalb, IL 60115) L. D. McGinnis, R. M. Otis, and M. L. Hall
A computer algorithm is described that automates the processing of refraction data acquired by conventional, multichannel, seismic reflection profiling, beginning with the determination of the first arrival times and ending with a contoured velocity-depth section. Traces for several closely spaced shots are first summed to suppress noise. Each stacked trace is convolved with a box operator to convert the first break to a peak that can be detected by the computer. The algorithm calculates intercept times using running averages of slopes. Depths to refractors are plotted and a velocity-depth profile, interpolated at constant velocity intervals, is printed as a contoured cross-section. A profile crossing Georges Bank, northwest Atlantic Ocean, is interpreted by both automatic and manual techniques for comparison.
GEOPHYSICS, VOL. 48, NO. 5

0930 Seismic methods
ANOMALOUS SEISMIC CHARACTER--BERING SEA SHELF
Roger G. Hammond (Exxon Company, U.S.A., P.O. Box 4279, Houston, TX 77001) John S. Gaither
Seismic data collected within basins along the outer Bering Sea Shelf often exhibit a distinct change in seismic character between 1.6 and 2.0 sec two-way time. This change appears on seismic sections as a reflector or as an increase or decrease in amplitude. The lesters is of regional extent.
This change in seismic character is a manifestation of what has been called in other basins a bottom simulating reflector (BSR). BSRs are reflectors that (1) are sub-parallel with sea floor topography, (2) are discordant with stratigraphy where the sea floor dictates, and (3) do not demonstrate all the characteristics of a multiple. Two causes of BSRs are generally accepted. One involves an ice-like mixture of water and gas, called "gas hydrate," in which gas molecules are trapped within a framework of water molecules. The other cause involves the diagenetic alteration of biogenic opal-A to opal-CT in diatomaceous sediments.
BSRs were penetrated at three locations in the Bering Sea in water depths greater than 1000 m on leg 19 of the Deep Sea Drilling Program (DSDP). The BSRs at these locations were attributed to the diagenetic alteration of opal-A. This same diagenesis of opal-A to opal-CT is interpreted to be the cause of seismic character changes noted in basins on the Bering Sea Shelf.
Pitfalls in seismic interpretation may be encountered where this reflector intersects other reflectors at an observable angle. The BSR may look like a sequence boundary or a direct hydrocarbon indicator.
Recognition of the presence of this seismic character change is of two-fold importance to exploration(ists): (1) it aids the understanding of the geology of the Bering Sea Shelf, and (2) it helps avoid seismic interpretational pitfalls.
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0930 Seismic methods
PREDICTIVE DECONVOLUTION IN SHOT-RECEIVER SPACE
Larry Morley (Geophysics Research and Development, Aramco, Dhahran, Saudi Arabia) Jon Claerbout
Standard predictive multiple suppression techniques in marine reflection seismology usually resort to one-dimensional assumptions about the underlying earth model. The methods presented here use a multiple model which assumes vertical incidence propagation in the water layer, yet relaxes common assumptions of zero offset and zero dip. In particular, different reflectivities and water depths are assumed at source and receiver locations.
One of these methods, seafloor-consistent multiple suppression, models each seismic trace as a convolution of an average frequency response with anomalous shot, geophone, midpoint, and offset responses. In the log-frequency domain, this becomes a separable, additive model which can be solved by linear least-squares techniques. The anomalous amplitude responses are solved for each frequency in a "shot-receiver" space with frequency as the outer loop of the algorithm.
Once the seismic data set has been resolved into average and anomalous amplitude responses, the multiple reverberation response is identified with the product of the anomalous shot and geophone response. Since one can argue on physical grounds that the reverberation response for any particular trace must be minimum phase, it suffices to solve only for amplitude responses and ignore phase contributions.
The methods are applied to a deep water marine seismic line from the Flemish Cap area of the Labrador Sea with extremely encouraging results.
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0930 Seismic methods
NOISE ATTENUATION BY VIBROSEIS WHITENING (VSW) PROCESSING
Cahit Coruh (Istanbul University, Vezneciler, Istanbul, Turkey; and Regional Geophysics Laboratory, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061) John K. Costain
Reflection seismic data recorded on the Atlantic Coastal Plain to examine suspected faulting of the shallow (200 m) basement were contaminated by severe ground roll noise with an apparent velocity of 90 m/sec, 25 Hz dominant frequency, and 22 m apparent wavelength. A receiver interval of 5 m and a 240 m spread length of 245 m were used to obtain 24-fold coverage. Although the noise problem was severe, overlapping source and/or receiver arrays on the surface were not used for the recording geometry in order to avoid a decrease in resolution caused by the smoothing effect of overlapping subsurface coverage. Instead, the large-amplitude surface waves were attenuated by a process called Vibroseis whitening (VSW).
VSW is based on the application of time-varying amplitude scaling before Vibroseis crosscorrelation. A conventional method of automatic digital gain control was found to be effective for this purpose. This scaling results in a signal-to-noise ratio improvement equal to the gain expected from crosscorrelation. The scaling window length and the length of sweep are the only parameters required to define the signal-to-noise improvement for a given swept-frequency band. A short scaling window and longer sweep length give better results because of the higher gain obtained in crosscorrelation.
An increase in the quality of Atlantic Coastal Plain data clearly showed that VSW processing resulted in high resolution on stacked sections and made it possible to map shallow basement reflections at 11 msr, revealing faults with up to 10 m offset. Reflections from the sedimentary section above basement also became distinct.
GEOPHYSICS, VOL. 48, NO. 5

Geodesy and Gravity

1990 General or miscellaneous
LACOSTE AND ROMBERG STRAIGHT-LINE GRAVITY METER
Lucien LaCoste (LaCoste and Romberg Gravity Meters, Inc., 4606 N. Lamar, Austin, TX 78752)
The LaCoste and Romberg straight-line gravity meter uses a new suspension in which the movable element moves vertically in a straight line rather than in an arc of a circle (LaCoste, 1973a). It was designed primarily for shipboard operation to avoid effects from cross coupling between various ship accelerations, thereby making it unnecessary to correct for such effects.
The straight-line suspension is a modification of the zero length spring suspension used in all LaCoste and Romberg gravity meters. The new model also uses silicone fluid damping rather than the air damping used in earlier models. Its main advantages over the older models appear to be that it is (1) free of cross-coupling effects, (2) easier to build and adjust, (3) less subject to slight degradation in performance from rough handling, and (4) less sensitive to ship vibrations.
In spite of the above advantages it is doubtful whether the new model will give substantially better accuracy than the previous models, if the previous models are kept in good operating condition by using occasional crosscorrelation analyses (LaCoste, 1973b). Valliant (1983, this issue) describes sea trials of the new instrument.
GEOPHYSICS, VOL. 48, NO. 5

1990 General or miscellaneous
FIELD TRIALS WITH THE LACOSTE AND ROMBERG STRAIGHT-LINE GRAVIMETER
H. O. Valliant (Earth Physics Branch, Department of Energy, Mines and Resources, 1 Observatory Crescent, Ottawa, Ont., Canada K1A 0Y3)
During field tests in 1980, the prototype of the LaCoste and Romberg straight-line gravimeter (SL-1) generally produced gravity values intermediate between those of two comparison "S" meters (S-36 and S-41). Correlation analysis shows that the data from SL-1 with no cross-coupling correction are 18 percent smoother even in rough weather than the corrected data from either S meter. When corrections for the cross-coupling effects are applied through postcruise correlation techniques, the corrected data (degree of smoothness) of the respective data agree to within 8 percent for each meter. These results verify that cross-coupling errors have been virtually eliminated in the new gravimeter.
GEOPHYSICS, VOL. 48, NO. 5

Geomagnetism and Paleomagnetism

1560 Time variations, paleomagnetism
HIGH MEDIEVAL AURORAL INCIDENCE OVER CHINA AND JAPAN: IMPLICATIONS FOR THE MEDIEVAL SITE OF THE GEOMAGNETIC POLE
George L. Siscoe (Department of Atmospheric Sciences, University of California, Los Angeles, 90024), Kenneth L. Verosub
The catalog of historical oriental auroras compiled by Keimatsu lists 118 auroras from China and 31 auroras from Japan in the period 801 to 1400 AD. The two listings have no events in common. If they are considered as independent random samples from the same population, the lack of overlapping events can be used to determine the probabilities of different medieval auroral occurrence frequencies over the China-Japan quarter. We find that there is a 95 percent probability that the average rate exceeded two per year. This is more than a factor of 20 greater than the inferred present rate. There is a 50 percent probability that the average rate exceeded eight per year, more than a factor of 80 greater than the inferred present rate. The calculated rates of auroral incidence can be used to estimate the medieval position of the geomagnetic pole. In both of the probability examples cited, the pole was located in the Eastern Hemisphere. In the first example it would have been displaced 9 degrees from the geographic pole, and in the second example, 17 degrees from the geographic pole. (Paleomagnetism, aurora, secular variation).
Geophys. Res. Lett., Paper 3L0305

2560 Time variations, paleomagnetism
HIGH MEDIEVAL AURORAL INCIDENCE OVER CHINA AND JAPAN: IMPLICATIONS FOR THE MEDIEVAL SITE OF THE GEOMAGNETIC POLE
George L. Siscoe (Department of Atmospheric Sciences, University of California, Los Angeles, 90024), Kenneth L. Verosub
The catalog of historical oriental auroras compiled by Keimatsu lists 118 auroras from China and 31 auroras from Japan in the period 801 to 1400 AD. The two listings have no events in common. If they are considered as independent random samples from the same population, the lack of overlapping events can be used to determine the probabilities of different medieval auroral occurrence frequencies over the China-Japan quarter. We find that there is a 95 percent probability that the average rate exceeded the inferred present rate by more than a factor of 20. This corresponds to a geomagnetic pole located in the Eastern Hemisphere displaced more than 9 degrees from the geographic pole. (Paleomagnetism, aurora, secular variation).
Geophys. Res. Lett., Paper 3L0305

Physics of the Solid Earth
Volume 18, Number 6

Atmospheric and Oceanic Physics
Volume 18, Number 9

Hydrology

1830 Groundwater
IDENTIFYING SOURCES OF GROUNDWATER POLLUTION: AN OPTIMIZATION APPROACH
S. M. Gorelick (U. S. Geological Survey, Menlo Park, California, 94025), B. Evans and I. Remson (Department of Applied Earth Sciences, Stanford University, Stanford, California, 94305)
Least squares regression and linear programming for least absolute error estimation are each combined with groundwater solute transport simulation to identify the locations and magnitudes of aquifer pollutant sources. Pollutant sources are identified by matching simulated and measured non-recurring solute concentration data. We have assumed known hydraulic parameters but considered concentration data errors explicitly. The identification models are demonstrated and compared using two hypothetical aquifer systems, one for the steady-state case and the other for the transient case. Steady-state models identified unknown pipe leak locations and leak magnitudes based upon sparse and spatially distributed chloride and tritium data. The number of likely leak locations was restricted in the models by employing mixed-integer programming and stepwise multiple regression. Transient models identified several annual disposal fluxes in the aquifer based upon concentration histories collected at observation wells. In this case conservative solute concentration data were abundant and contained substantial errors. Minimizing either least absolute or least squared errors was successful in identifying pollutant sources. Furthermore, we demonstrate error analysis for the results given by either method.
Water Resour. Res., Paper 1W0406

1199 General or miscellaneous
THERMAL HYDROLOGY AND HEAT FLOW OF BEOWAWE GEOTHERMAL AREA, NEVADA
Christian Smith (Formerly Earth Science Laboratory, University of Utah Research Institute, Salt Lake City; presently Chevron Resources Co., P.O. Box 7147, San Francisco, CA 94107-7147)
Inflections in temperature-depth profiles from forty 150 m thermal gradient holes define a shallow thermal flow system in the Whirlwind Valley near the Beowawe Geysers. U.S. Geological Survey hydrologic data reveal the vertical and east-to-west components of cold water flow at the water table above the thermal flow system. The temperature inflections break most abruptly in areas with a downward component of flow at the water table. The inflections are thought to indicate the level where the buoyant thermal water maintains a dynamic equilibrium with the overlying cold water. Combining these geophysical and hydrologic data suggests areas away from viable geothermal exploration targets. Even if the temperatures of the leakage were subeconomic, knowledge of where upwelling occurs could be helpful in assessing the potential for energy production. The systematic acquisition of hydrologic data is recommended as a standard component of hydrothermal resource exploration programs.
Measurements of thermal conductivity from chip samples from the shallow holes and from Chevron Resources Company's Ginn 1-13 geothermal exploration hole (7917 m T.D.) enable inferences based on heat flow. The average heat flow east of the Dunphy Pass fault zone, 110 mW/m², may be representative of background in this portion of the Battle Mountain high heat flow province. Thermal gradient and conductivity data from the deep well have a wide range of values (65-144°C/km, 1.59-5.95 Wm⁻¹K⁻¹) but produce a relatively constant heat flow of 235 mW/m² above a depth of 1600 m. The shallow data indicate that the area with similarly high surficial heat flow extends as far east as the Dunphy Pass fault zone, suggesting that this Miocene rift boundary may form the eastern margin of the Beowawe hydrothermal system.
GEOPHYSICS, VOL. 48, NO. 5

Meteorology

3715 Chemical Composition
FOGWATER CHEMISTRY IN AN URBAN ATMOSPHERE
J. W. Munger, D. J. Jacob, J. M. Waldman and M. R. Hoffmann (Environmental Engineering Science 138-78, California Institute of Technology, Pasadena, California, 91125)
Analyses of fogwater collected by inertial impaction in the Los Angeles basin and the San Joaquin Valley indicated unusually high concentrations of major and minor ions. The dominant ions measured were NO_3^-, SO_4^{2-}, NH_4^+, and H^+. Nitrate exceeded sulfate on an equivalent basis by a factor of 2.5 in the central and coastal regions of the Los Angeles basin, but was approximately equal in the eastern Los Angeles basin and the San Joaquin Valley. Maximum observed values for NH_4^+, NO_3^- and SO_4^{2-} were 10., 11., and 5. meq L^{-1}, while the lowest pH observed was 2.2. Iron and lead concentrations over 0.1 mM and 0.01 mM, respectively, were observed. High concentrations of chemical components in fog appeared to correlate well with the occurrence of smog events. Concentrations in fogwater were also affected by the physical processes of condensation and evaporation. Light, dissipating fogs routinely showed the highest concentrations. (Fogwater composition, sulfur oxidation, aerosol scavenging, condensation, evaporation, condensation nuclei, nitrate scavenging, aerosol haze).
J. Geophys. Res., Green, Paper 3C0293

3715 Chemical composition and chemical interactions
LATITUDINAL VARIATION OF TROPOSPHERIC OZONE IN A PHOTOCHEMICAL MODEL
Sultan Hameed (Laboratory for Planetary Atmospheres Research and Department of Mechanical Engineering, State University of New York, Stony Brook, New York, 11794), Richard W. Stewart
A zonally, vertically and annually averaged numerical model of trace gases in the troposphere is used to examine the variation of ozone as a function of latitude. Processes included in the ozone budget are a source due to downward transport of ozone from the stratosphere, deposition at earth's surface, north-south diffusive transport and photochemical reactions. Sensitivity of calculated ozone concentrations to the latitude variation and magnitude of the stratospheric source is presented. The model indicates a net photochemical source of ozone in the northern hemisphere and a net chemical sink in the tropical latitudes. Calculated variation of ozone concentration with latitude is in qualitative agreement with observations. (Troposphere, ozone).
J. Geophys. Res., Green, Paper 3C0279

5745 Gravity Waves, Tides, and Compressional Waves
A NUMERICAL MODEL OF GRAVITY WAVE BREAKING AND STRESS IN THE MESOSPHERE
M.R. Schoeberl, D.F. Strobel, and J.P. Apruzese (Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375)
The stresses generated by breaking gravity waves in the mesosphere are calculated with a numerical model of steady vertically propagating gravity waves which includes wavelength dependent radiative dissipation and turbulent viscosity and conduction. The principal findings are: (1) waves do not break for $|\lambda_z| \lesssim 20$ km as radiative damping prevents wave amplitude growth with altitude for short vertical wavelengths; (2) the downward heat flux due to turbulence of breaking waves and turbulent heating through loss of wave energy could severely affect the global radiative energy balance; and (3) predicted zonal decelerations for steady breaking waves is stronger than required by Apruzese et al. [1982] for the mean circulation. Gravity wave breaking may be an intermittent process; otherwise, gravity wave stresses would produce an adiabatic mesosphere with a zonal mean velocity close to the phase speed of the breaking wave.
Diffusive transport of constituents and potential temperature by breaking gravity wave turbulence is shown to be important. In the cases of nitric oxide and atomic oxygen the vertical eddy diffusion coefficients are shown to be sensitive functions of their respective chemical loss rates in the mesosphere and lower thermosphere. (Gravity waves, wave breaking, mesosphere).
J. Geophys. Res., Green, Paper 3C0347

3770 Meteorology (Particles and Aerosols)
LIDAR OBSERVATIONS OF THE EL CHICHON DUST CLOUD AT 23°S
B. R. Clemesha (Instituto de Pesquisas Espaciais, S.J. dos Campos, S.P., Brazil) and D.M. Simonich
Lidar observations of the stratospheric aerosol scattering at São José dos Campos (23°S, 46°W) show a very large increase in the stratospheric aerosol burden to have occurred in mid-1982. Peak scattering ratios greater than 5 have been observed, as compared with pre-enhancement values between 1.1 and 1.2, representing an increase by more than an order of magnitude in particulate scattering. It is concluded that the main source of the dust was the eruption of El Chichón in Mexico in late March and early April of 1982. (Stratospheric aerosols, volcanic eruptions).
Geophys. Res. Lett., Paper 3L0329

Oceanography

4760 Sea ice
SENSITIVITY STUDIES WITH A COUPLED ICE-OCEAN MODEL OF THE MARGINAL ICE ZONE
L.P. Roed (Research Division, Det norske Veritas, P.O. Box 300, N-1322 Hovik, Norway)
An analytical coupled ice-ocean model is considered which is forced by a specified wind-stress acting on the open ocean as well as the ice. The analysis supports the conjecture that the upwelling dynamics at ice edges can be understood by means of a simple analytical model. In similarity with coastal problems it is shown that the ice edge upwelling is determined by the net mass flux at the boundaries of the considered region. The model is used to study the sensitivity of the upwelling dynamics in the marginal ice zone to variation in the controlling parameters. These parameters consist of combinations of the drag coefficients used in the parameterization of the stresses on the three interfaces atmosphere-ice, atmosphere-ocean and ice-ocean. The response is shown to be sensitive to variations in these parameters in that one set of parameters may give upwelling while a slightly different set of parameters may give downwelling. (Coupled ice-ocean behavior, analytic model, ice-edge upwelling, ice edge motion).
J. Geophys. Res., Green, Paper 3C0483

Particles and Fields—Ionosphere

5585 Airglow
THE EXTREME ULTRAVIOLET DAY AIRGLOW
S. Chakrabarti, F. Paresce, S. Bowyer and R. Kimble (Space Sciences Laboratory, University of California, Berkeley, California 94720); R. Kumar (Earth & Space Sciences Institute, University of Southern California, Los Angeles, California 90007)
Satellite observations of the earth's extreme ultraviolet day airglow between 350 and 1400 Å are described. The atomic spectrum shows lines of O II (430-439, 555, 601, 617, 673, 718, 834), He I 584, O I (989, 1152, 1304, 1356), N II (916, 1085), N I (1134, 1200), and H I (1025, 1216, and possibly 975). Previously unobserved weak O II lines (515, 482, 470, 467) are observed below 550 Å. The Lyman-Birge-Hopfield (LBH) and Birge-Hopfield (BH) bands of N_2 between 900-1100 Å are the dominant molecular lines. Large scale high latitude and equatorial enhancements and hemispheric asymmetries are evident in the east zenith O II 834, O I 989 and H I 1025 Å line intensities.
J. Geophys. Res., Blue, Paper 3A1929

5515 Auroras
ANALYTICAL YIELD SPECTRUM APPROACH TO ELECTRON ENERGY DEGRADATION IN EARTH'S ATMOSPHERE
S. A. Haider (Applied Physics Section, Institute of Technology, Banaras Hindu University, Varanasi, 221005, India) and R. P. Singhal
Analytical spatial yield spectrum approach has been applied to calculate the electron flux, volume excitation and ionization rates for monoenergetic electrons incident on the earth's atmosphere. The results have been compared with the previous model calculations of Mantas and Walker (1976) and Banks et al. (1974). (Electrons, ionization).
J. Geophys. Res., Blue, Paper 3A0357

5520 Electric fields
LATITUDINAL AND MAGNETIC FLUX TUBE EXTENSION OF THE EQUATORIAL SPREAD F IRREGULARITIES
M. A. Abdu (Instituto de Pesquisas Espaciais - INPE, Conselho Nacional de Desenvolvimento Cientifico e Tecnológico - CNPq, 12200 - São José dos Campos, São Paulo, Brazil), I. S. Batista, and Y. Nakamura
A comparative study has been carried out of the spread F occurrence characteristics at the magnetic equatorial station, Fortaleza (4°S, 38°W, dip latitude 1.8°S) and the low-latitude station, Cachoeira Paulista (22°S, 45°W, dip latitude 14°S) located with a relatively small longitudinal difference, in Brazil. The results show strong correlation between the occurrences of spread F events at the two stations for most of the time. While all the spread F events over Cachoeira Paulista are accompanied by such events over Fortaleza, the converse is not true. Also, the spread F onset times over the equator are systematically earlier than those over the low latitude. Another interesting result is that while the spread F durations at the two stations are approximately linearly related, an event over Cachoeira Paulista is observed only for those that have durations more than 4-5 hours over Fortaleza. Possible implications of these results on the plasma bubble rise velocities in the equatorial ionosphere are discussed. It seems possible also to predict the approximate duration of a spread F event over the equator by observations carried out at a low-latitude station situated close to a common magnetic meridional plane. (Spread F, plasma bubble, latitudinal extension of the irregularities).
J. Geophys. Res., Blue, Paper 3A1704

5535 Interactions Between Waves and Particles
DIRECT OBSERVATION OF RADIATION BELT ELECTRONS PRECIPITATED BY THE CONTROLLED INJECTION OF VLF SIGNALS FROM A GROUND-BASED TRANSMITTER
W. L. Imhof (Lockheed Palo Alto Research Laboratory, 3251 Hanover St., Bldg. 255, Palo Alto, Calif. 94304), J. R. Reagan, E. E. Gaines, D. W. Datlowe, J. Mobilia, R. A. Helliwell (Stanford University), U. S. Inan, J. Katsufrakis, and R. G. Joiner (Office of Naval Research)
Radiation belt electrons precipitated by controlled injection of VLF signals from a ground based transmitter have been directly observed for the first time. These observations were part of the SEEP (Stimulated Emission of Energetic Particles) experiment conducted during May - December 1982. Key elements of SEEP were the controlled modulation of VLF transmitters and a sensitive low altitude satellite payload to detect the precipitation. An outstanding example of time-correlated wave and particle data occurred from 8680 to 8740 seconds U.T. on 17 August 1982 when the satellite passed near the VLF transmitter at Cutler, Maine (NAA) as it was being modulated with a repeated ON (3-s)/OFF (2-s) pattern. During each of twelve consecutive pulses from the transmitter the electron counting rate increased significantly after start of the ON period and reached a maximum about 2 seconds later. The measured energy spectra revealed that approximately 15 to 50 percent of the enhanced electron flux was concentrated near the resonant energies for first order cyclotron interactions occurring close to the magnetic equator with the nearly monochromatic waves emitted from the transmitter.
Geophys. Res. Lett., Paper 3L0320

5545 Ionospheric disturbances
UNIFIED THEORY OF TYPE I AND TYPE II IRREGULARITIES IN THE EQUATORIAL ELECTROJET
R. N. Sudan (Laboratory of Plasma Studies, Cornell University, Ithaca, New York 14853)
A nonlinear unified theory of type I and II irregularities is presented which explains their principal observed characteristics. The power spectrum is predicted using Kolmogoroff type conservation law for the power flow in cascading eddies. (type I and II irregularities, equatorial electrojet, nonlinear unified theory)
J. Geophys. Res., Blue, Paper 3A0371

5545 Ionospheric disturbances
EFFECT OF AN ELECTRON BEAM ON THE CURRENT-CONVECTIVE INSTABILITY
P.K. Chaturvedi and S.L. Ossakow (Code 4700, Naval Research Laboratory, Washington, D.C. 20375)
We consider the possible effects of an electron beam on the current-convective instability in a weakly-ionized plasma, with application to the diffuse auroral situation. A linear stability analysis including these effects is presented. It is found that the presence of an electron beam has negligible effects on the instability growth rate for the diffuse auroral ionospheric application. (Electron beam, convective instability, diffuse aurora)
J. Geophys. Res., Blue, Paper 3A0834

5545 Ionospheric disturbances
SHORT WAVELENGTH STABILIZATION OF THE GRADIENT DRIFT INSTABILITY DUE TO VELOCITY SHEAR
J.D. Huba (Geophysical and Plasma Dynamics Branch, Plasma Physics Division, Naval Research Laboratory, Washington, D.C. 20375), L.C. Lee (Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701)
A nonlocal analysis of the gradient drift instability is presented. The new effect included in this theory is the allowance for an inhomogeneous electric field which produces a sheared drift velocity. It is found that velocity shear can stabilize the short wavelength modes of the instability, and preferentially excite a longer wavelength mode than would be expected based upon local theory. This result may explain the observations of dominant, long wavelength irregularities in the equatorial electrojet (Kudeki et al., 1982; Pfaff et al., 1982) and be relevant to irregularities in the auroral ionosphere.
Geophys. Res. Lett., Paper 3L0331

5545 Ionospheric Disturbances
ON THE GENERATION AND GROWTH OF EQUATORIAL BACKSCATTER PLUMES, 2. STRUCTURING OF THE WEST WALLS OF UPWELLINGS
R. T. Tsunoda (Radio Physics Laboratory, SRI International, Menlo Park, CA 94025)
The west wall of large-scale "upwellings" that develop in the bottomside of the nighttime equatorial F layer becomes structured by the wind-driven gradient-drift instability, the same process that leads to the formation of striations in barium ion clouds. Upwellings are initiated by wavelike perturbations with long spatial wavelengths (~ 400 km) and are amplified by the collisional Rayleigh-Taylor instability (and sometimes assisted by the gradient-drift instability in the case of an upward moving F layer). The west-wall structuring process is driven by an eastward neutral wind enhanced by reduced drag during the post-sunset hours and a velocity shear in east-west bulk plasma drift in the bottomside F layer. West wall structures evolve in a manner analogous to primary plasma bubbles; i.e., secondary plasma bubbles grow from the west wall. Their characteristics are compared with those of the primary bubbles and discussed in the light of existing theories. (Equatorial spread F, equatorial irregularities, plasma bubbles, gradient-drift instability).
J. Geophys. Res., Blue, Paper 3A0397

5560 Particle precipitation
SATELLITE AND GROUND OBSERVATIONS OF A PRE-SUBSTORM PHASE ON 4 MAY 1977
Aarne Ranta and Hilkka Ranta (Geophysical Observatory, SF-99600 Sodankylä, Finland)
On 4 May 1977 a polar orbiting low-altitude DMSP satellite passed close to the Finnish riometer stations, at the same time as an absorption bay preceding an onset of substorm was observed. The combined ground and satellite measurements show that the absorption bay was characterized by intense precipitation of energetic electrons at the inner border of the compressed plasma sheet. The precipitation occurred in a narrow band of latitude, perhaps less than 50 km wide. We suggest that the pre-bay precipitation was due to strong pitch angle diffusion and/or scatter of energetic electrons at the inner border of the plasma sheet, probably from the outer radiation zone. (Substorm, energetic particle precipitation).
J. Geophys. Res., Blue, Paper 3A0247

5568 Particle precipitation
A THEORETICAL APPROACH TO THE MORPHOLOGY AND THE DYNAMICS OF DIFFUSE AURORAL ZONES
O. Fontaine (CNET/CRPE, 38-40 rue du Général Leclerc, 92131 - Issy-les-Moulineaux, France) and M. Blanc.
Direct observations of the high-latitude ionosphere have established the continuous presence of large-scale emissions, referred to as diffuse auroras. Neglecting located structures, such as discrete arcs, we focus upon a quantitative description of the coupling of the large-scale processes of convection and diffuse precipitation.
The transport of 100 eV-10 keV electrons from the geomagnetic tail eastward by the convection electric field, and their pitch-angle diffusion into the loss-cone by wave particle interactions, are believed to be the main cause of diffuse auroral electron precipitation. A self-consistent treatment balancing wave generation and particle diffusion appears to be still beyond the present state of the art.
For the main purpose of magnetospheric convection modelling, we propose a simplified approach to this problem, and test its validity against direct observations of the location and dynamics of diffuse auroral emissions. Using basically the strong pitch-angle diffusion limit in the way proposed by Kennel (1969), we derive a set of fluid equations describing the three-dimensional transport of plasma-sheet electrons. Their integration provides the latitude and local time distribution of precipitation fluxes and characteristic energies at the top of the ionosphere as a function of the large-scale dawn to dusk electrostatic potential drop.
The calculated expansion of the auroral oval with magnetic activity deduced from our model, approaches the experimental results. So this simplified theoretical study permits us to reproduce and explain the main characteristics of the diffuse auroral zone. However, for high values of magnetic activity, the theoretical results are found to be shifted poleward relative to the observations. It suggests that the assumption of strong pitch-angle diffusion overestimates the efficiency of wave-particle interactions. (Electron precipitation, convection electric field, diffuse aurora).
J. Geophys. Res., Blue, Paper 3A0335

5570 Total electron content
ON THE FORMATION OF DAYTIME TROUGHS IN THE F-REGION WITHIN THE PLASMASPHERE
J. V. Evans (MIT Lincoln Laboratory, Lexington, Massachusetts 02173), J. M. Holt and R. H. Wand
Abstract. We have reported previously Millstone Hill incoherent scatter radar observations of a trough that formed in the ionosphere near Λ = 65° during the daytime (on 26 February 1979) in association with very disturbed magnetic conditions. In this paper, we report differential-Doppler observations of latitudinal variations of total electron content made at Millstone Hill over the two-year period 1971-1973, during which data were collected for over 2,000 passes of the polar-orbiting Navy Navigation Series satellites. These showed that the formation of a trough in the daytime is a rare but not unique event. Such troughs were seen on six days during this observing campaign at Λ < 68°; all of these were magnetically disturbed days and occurred in winter. These troughs were seen to move rapidly equatorwards during the course of the afternoon. This suggests that they represent the signature of some externally impressed effect such as an intense electric field as was found to be the case on 26 February 1979. We suggest that these troughs are the ionospheric signature of electric fields impressed into the ionosphere by the charge distribution in the magnetosphere of the partial ring current.
Geophys. Res. Lett., Paper 3L0327

5593 General or miscellaneous
SOUNDER-ACCELERATED PARTICLES OBSERVED ON ISIS
R.O. James (Communications Research Centre, Department of Communications, Ottawa, Canada K2H8S2)
The soft-particle spectrometers aboard the ISIS I and ISIS II detect Sounder-Accelerated Particles (SAP), i.e. fluxes of electrons and ions energized by the 100-µsec transmitter pulse (nominal peak power: 400 W). Fluxes of up to 10^{9} $ster^{-1}$ eV^{-1} cm^{-2} sec^{-1} are observed. Typical highest ion and electron energies are several hundred electronvolts and 100-200 eV, respectively. SAP electron fluxes on ISIS II are energized near the major electron resonant frequencies: f_{pe} (plasma frequency), f_{ce} (gyrofrequency), $2f_{ce}$ and the oblique resonance frequency domains. Ion fluxes are present from the lowest sounder frequency (0.1 MHz) up to the greater of f_{pe} and f_{ce}. Electrons are observed at pitch angles near 90° while ions are present at all pitch angles. The observations can be interpreted using a model of particle motion and spacecraft dc potential both induced by the intense rf field (≈ 100 V/m). The ion results indicate that at $f > f_{pe}, f_{ce}$, a negative potential of about 100 V is on the spacecraft, whereas at $f > f_{pe}, f_{ce}$, the potential is much smaller. ISIS-1 data from equatorial perigee conditions show that electrons remain energized for a few milliseconds after the end of the rf pulse. (Particles, sounder-accelerated)
J. Geophys. Res., Blue, Paper 3A0785

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